

UNIT IV

- ❖ Hydroelectricity:
The Shad Story
- ❖ Acid rain and scrubbing
- ❖ Environmental investigators
- ❖ decision making:
Building a New Power Plant

Environmental Impacts

Environmental Impacts

4.1 Hydroelectricity – *The Shad Story*

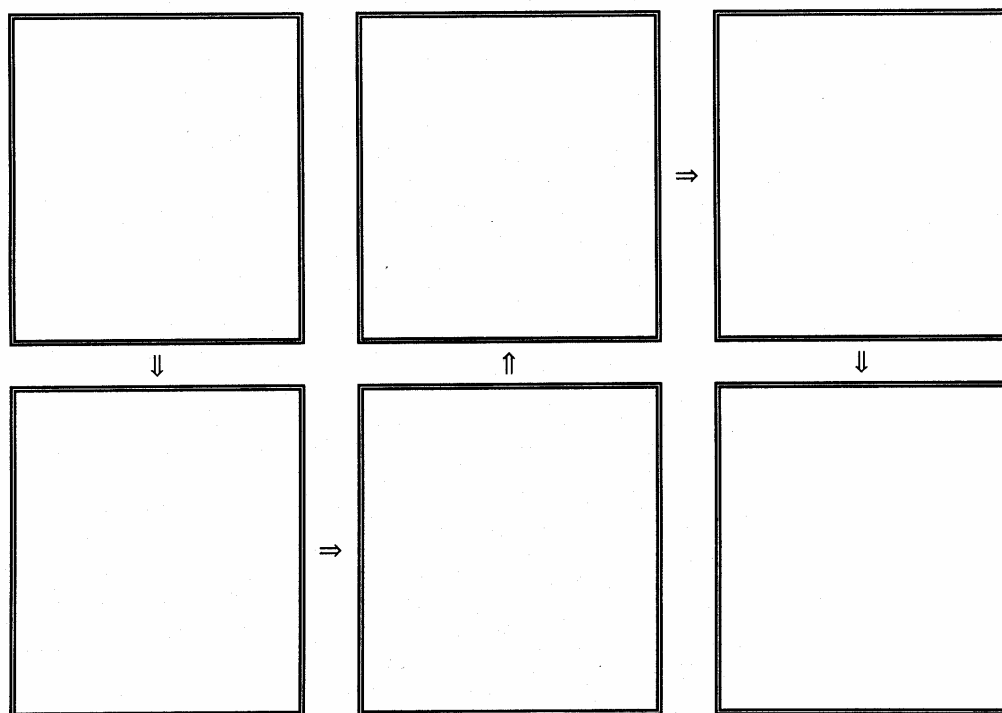
Overview:

You have just heard about plans for a new power plant in your area. As a concerned citizen, you are worried about the effects of power plants on Maryland's environment. You decide to research impacts about power plants in other areas of Maryland so that you can write an article informing the public about the possible pro's and con's of this new plant, as well as solutions to prevent or minimize impacts. The following activities will tell you about some past and present issues.

Activity A:

Read *The Return of the Shad* silently. As you read, think about the connection of power plants to the environment. Highlight the most important facts in the story.

The shad have struggled to survive many obstacles in the past few decades. Now complete the sequence chain showing supporting details of the article.



The Return of the Shad

Did you hear that the crab population is in danger? We all know that “Maryland is for Crabs,” as the T-shirts and bumper stickers say. What would our state be like without crabs? Hopefully, we will never find out. This is why the government is trying to protect the species by passing laws to limit the number of crabs people can catch, leaving more crabs in the Chesapeake Bay. We have learned a lot about the importance of its protection from past experiences. For example, the decline of the American shad made us more aware of human impacts on our surroundings. From the late 1800’s through the mid 1900’s, shad was the most valuable fish harvested in Maryland and Virginia. The number of catches fell sharply after the early 1970’s.

These **anadromous** fish (a fish that spends most of its life at sea but swims up rivers to spawn) have struggled to survive over the years. Overfishing, pollution and the blocking of waterways by dams have greatly reduced their numbers. The Conowingo Dam along the Susquehanna River in northern Maryland provides energy to thousands of people by using the water from the river to produce electricity. At the time the dam was built, the power company did not have the technology to successfully build a fish passageway. This river is

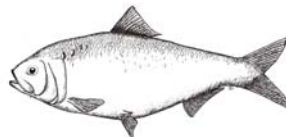
important for shad because they travel upstream to **spawn** (produce young). The dam blocked their way. The facility began efforts to help the shad get past the dam. In 1972, an experimental fish lift was built on the west side to trap the fish and carry them upwards to the top of the dam like an elevator. A \$12 million permanent fish lift was completed in 1991 on the east side of the Conowingo Dam. That still left three upstream dams blocking hundreds of miles of spawning habitat.

By the year 2000, all four hydroelectric projects along the river had installed fish passage facilities. Today the entire Susquehanna River is now open to migratory fish for the first time since the dams were constructed.

A **moratorium** (temporary suspension of fishing) was placed on shad fishing in Maryland to protect the fish. The moratorium and the stocking of young shad have also contributed to an increase in shad population.

Growth of the Susquehanna River shad stock in response to the restoration efforts and fish passage construction has been dramatic.

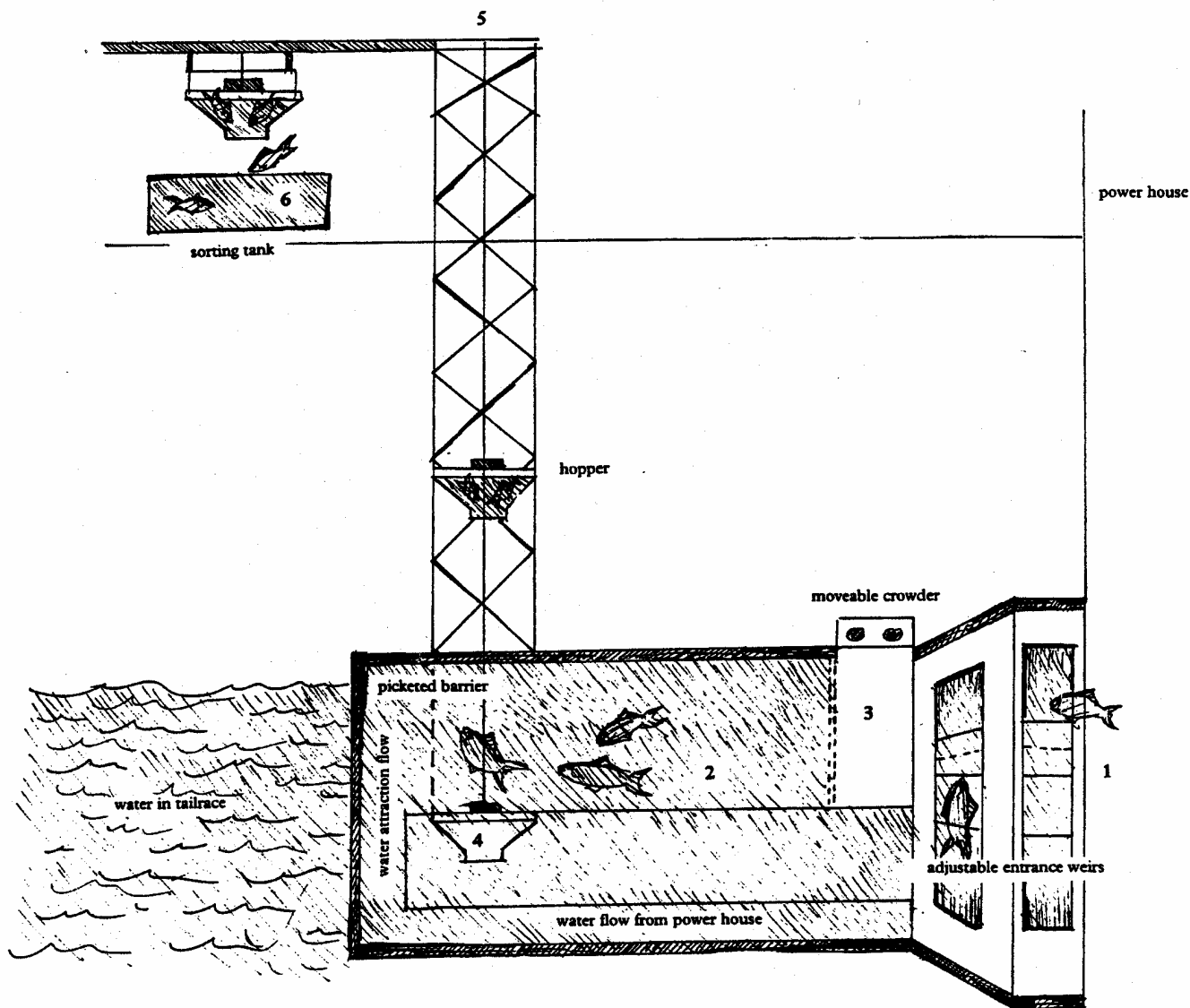
This is a fine example of cooperation and dedication between the U.S. Fish and Wildlife Service, state government agencies in Maryland, Pennsylvania, New York and electric suppliers!



Conowingo Fish Lift

Student Page

How it works!



The shad are attracted to entrance weirs (1) because of their instinct to swim against fast moving water. Once in the holding pool (2), the gates of the moveable crowder (3) are periodically closed and the crowder is moved to crowd the fish over the submerged hopper (4). The overhead crane (5) hoists the hopper, then travels horizontally and releases the collected fish into the sorting tank (6) for biological studies, or directly into a truck for transport to the upriver sites.

Activity B:

During the last decade, researchers have kept close watch over the shad population. The following data has been collected. The number of shad counted at Conowingo Dam between 1984 and 2003 reflects the efforts made by the power company, the U.S. Fish and Wildlife Service and the Pennsylvania and Maryland Natural Resource agencies. *Look over the information, and then create a graph making the data easier to understand. Don't forget to title and label your graph.* After you complete your graph, make a general observation about the shad population between the years 1984 and 2003.

Year	Shad	Year	Shad	Year	Shad	Year	Shad
1984	167	1989	8,218	1994	32,330	1999	75,220
1985	1,546	1990	15,719	1995	61,650	2000	153,546
1986	5,195	1991	27,227	1996	33,825	2001	193,574
1987	7,667	1992	25,721	1997	101,499	2002	108,001
1988	5,146	1993	13,500	1998	44,497	2003	125,135



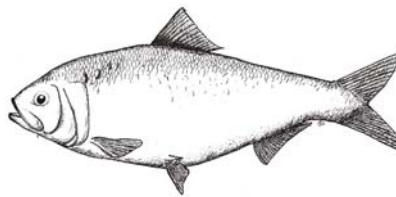
Activity C:

You will now take a position for your local population of shad. Choose one of the situations below and write a response.

Choice 1:

Large thriving populations of shad live in the Rocky Rhodes River. You have recently read an article in a local paper that the local power company decided to build a hydroelectric power plant on the river. You know what difficulties the other shad populations have endured on the Susquehanna River. In another issue of the paper, you read the story of “The Return of the Shad”. Although things worked out well in the end on the Susquehanna River, you are concerned about the future of the shad stock in the Rocky Rhodes River.

You decide to take immediate action. Write a letter to the manager of the Rocky Rhodes River Power Company persuading the manager to explore and obtain solutions to prevent or minimize harmful impacts of a dam on the shad population along the river. You should draw facts from the text, “The Return of the Shad,” to make your persuasion stronger. Try to acknowledge that you understand the manager’s point of view and that electricity is important and useful. Emphasize that you think electricity should be produced in a way that does not harm the environment, including the local shad.



Choice 2:

You live on the Susquehanna River. You have just learned about the history of the river in relation to the shad population from an article in your local newspaper entitled, “The Return of the Shad”. You are impressed by the efforts the power company has taken to protect the shad population on the river, so you decide to write a thank you letter to the Conowingo Dam facility. When writing a thank you note, be specific about the item/reason you are thanking the reader. Be sure to use details in your letter from the text of “The Return of the Shad”.

Environmental Impacts

4.2 Acid Rain and Scrubbing

Overview:

As a concerned citizen, you wonder how power plants affect the air quality. Acid rain is one problem we face. Read the following articles to find information about coal as a fuel source, acid rain and coal cleaning to reduce pollution. After you have read all of the articles to understand the connection between coal, pollution and power plants, you should begin the activities.

Part A – Advantages & Disadvantages:

Read the article, “Maryland News” and then view the diagrams “Cleaner Use of Coal” and “Making Coal Easier to Clean and Burn.” After you have read the article and diagrams, fill in the chart below.

Advantages of Using Coal	Disadvantages of Using Coal

Maryland News

Power Plants and the Environment: Coal as a Source of Energy

Why use coal? More than half the electricity used by American consumers is produced from coal-burning power plants. Let's explore some advantages and disadvantages of using coal. The U.S. has about one fourth of the world's total of coal, enough to last 250 years at today's rate of use. Using coal helps to save oil and natural gas, two other fossil fuels that are quickly being used up.

Unfortunately, coal is the nation's dirtiest fuel. Burning coal produces sulfur dioxide, nitrogen oxides and ash. When sulfur dioxide and nitrogen oxides mix with water in the atmosphere, it is converted to acid rain. In sunlight, nitrogen oxides combined with oxygen and volatile organic compounds (like gas fumes) create ground level ozone or smog.

Starting in the 1970's utilities began using devices to remove sulfur dioxide and fly ash from the power plant smoke. The Federal Clean Coal Technologies program further promoted ways to reduce pollution. U.S. EPA's Acid Rain Program also required power plants to reduce the plants nitrogen oxide levels. The efforts being taken by power plant companies as a result of these programs are a good start to reducing air pollution. However, we must not only look at the burning of fossil fuels as a problem but also at automobile emissions. In addition, the deforestation (clearing of trees) of the world's forests is another factor that affects the environment in relation to the air surrounding the earth.

Clean Coal Technologies

Many Maryland power plants use low-sulphur coal as the fuel to create steam. Several power plants use clean coal technology to reduce the amounts of

Maryland Department of Natural Resources

pollutants in the atmosphere. For clean coal technology, the first step is to reduce the large chunks of coal into more workable pieces. The coal is crushed and then sorted by size. The coal is then put through cleaning processes. Clean Coal Technologies refer to several techniques that remove sulfur and nitrogen compounds before, during or after coal is burned. To find out how these processes work and to visualize what happens, look at the diagrams below

Adapted from Coal: Energy for Home and Community,
Pittsburgh Energy Technology.

Cleaner Use of Coal

? Cleaning Before Burning
Washing and drying coal
to remove pollutants
(Coal floats/impurities sink)
before coal is burned.



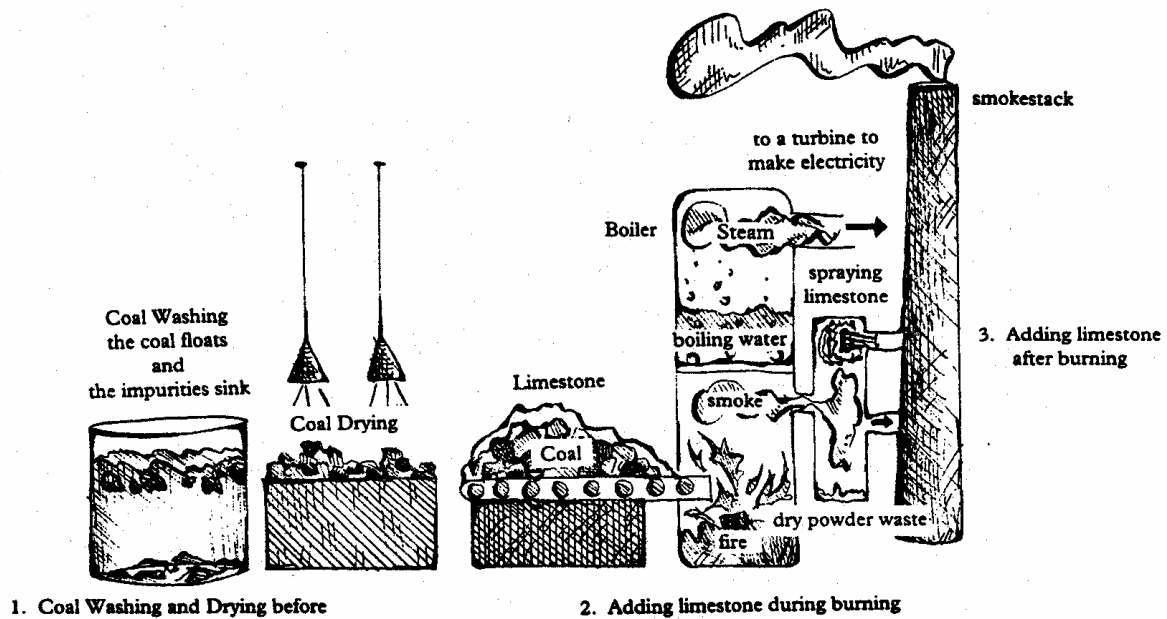
? Cleaning During Burning
Adding limestone
during burning to soak up
pollutants while coal burns.



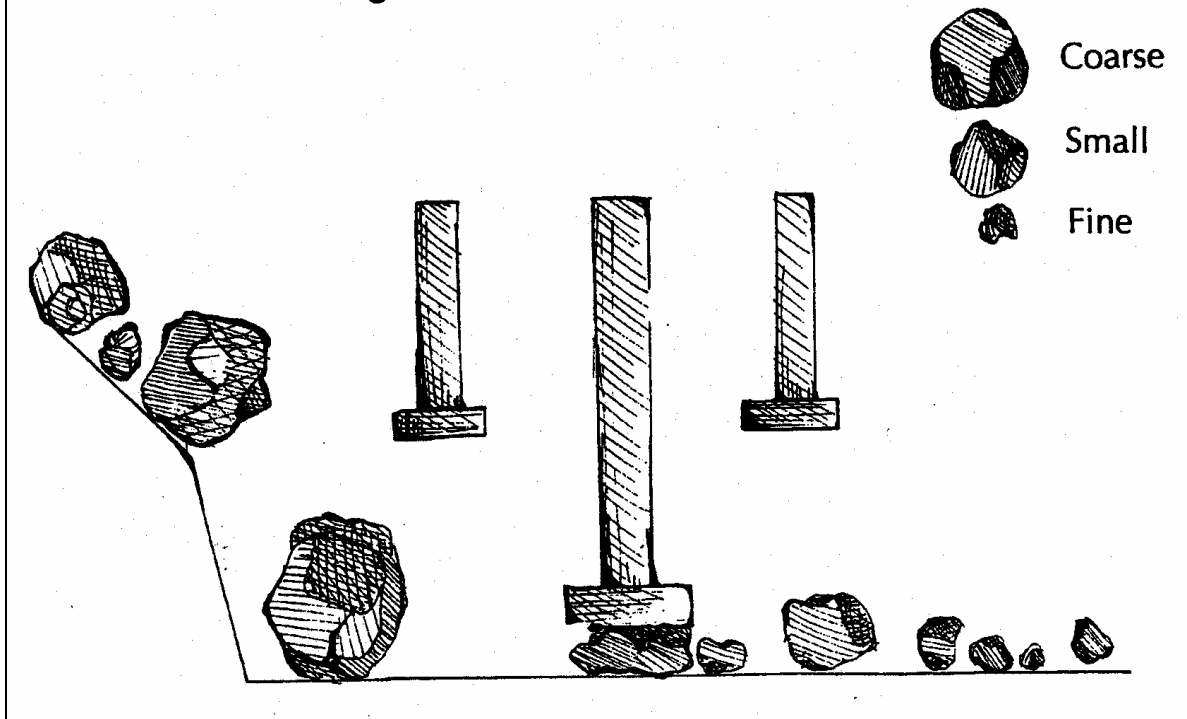
? Cleaning After Burning
Adding limestone to clean
pollutants from smoke
before releasing the exhaust
to the smoke stack and to our air.



Cleaner Use of Coal



Making Coal Easier to Clean and Burn



Acid Rain & Scrubbing

Part B – What is Acid Rain: Lets find out!

Studies show that certain sulfur and nitrogen compounds can combine with water in the air or on the ground to form acidic water. This acidic water can appear as rain, snow, hail or frost. It is believed that these acids can damage lakes, forests & streams.



What Causes Acid Rain?

Many scientists believe sulfur dioxide (SO_2) is the major cause, while another gas, nitrogen oxide (NO_x) also contributes to the acid in rain. We do know that exhaust from cars, trucks and buses is the main source of NO_x . In Maryland, power plants are responsible for nearly 2/3 (or 66%) of SO_2 (2003 data).



So, What's Being Done About It?

We certainly don't want to give up driving cars or using electricity, but we don't want to damage our environment either. That is why both the federal government and the electric power industry are investigating the causes of the problem and how to solve it.



Acid Rain & Scrubbing Why Worry?

Materials:

Litmus Paper

Lemon Juice

Rainwater

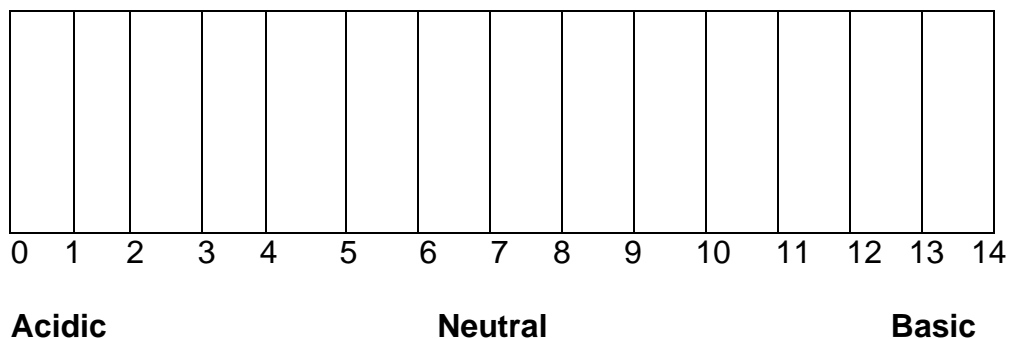
Ammonia

As mentioned in the acid rain article, it is believed these acids can damage some lakes, certain forests and streams. The amount of acid in water is measured using a pH scale (see below). The scale ranges from 0-14. The lower the pH number the more acid the liquid. A liquid with a pH of 7 is considered neutral. Actually, water that is quite acidic may not be dangerous for humans. For instance, we can drink lemon juice that has a pH of less than 3 (a rather high amount of acid). On the other hand, for plants and animals that live in water a low pH can be dangerous. If a lake's pH gets below 5, many fish will die.

Acid rain is also harmful to buildings and statues. Some of these structures are made from marble or limestone, substances easily dissolved by acid rain. The acid eats away the statues.

It is important to note that rain water, which is slightly acidic, averages between 5.0 and 5.6 on the pH scale. Sulfur dioxide (SO₂) and nitrogen oxide (NO_x) increase this acidity.

Label the pH scale below. Test the following with litmus paper - lemon juice, normal rainwater and ammonia. Draw a line with an arrow to indicate where these items occur on the pH scale.



The pH Scale and Acid Rain

Acid Rain & Scrubbing

PART C – Acid Rain Neutralization Lab

Background:

Acid rain forms when sulfur dioxide and nitrogen oxide (produced by the burning of fossil fuel) combine with water droplets in the atmosphere.

Coal burning power plants use several methods to prevent or cut down on the amount of acid forming agents entering our atmosphere. This lab will simulate the use of limestone in cleaning coal. Use the lab report in Part C to record the following information.

Grouping: 2-3 students

Problem Statement: How do coal-burning power plants reduce acid rain forming agents? Write one or two possibilities on your lab report.

Hypothesis:

I think adding limestone to an acid solution will/will not reduce the acidity because...

Materials:

- ❖ 8 ounce paper cup or 500 ml. Beaker
- ❖ Distilled water
- ❖ Acid source (distilled white vinegar, lemon juice)
- ❖ Granulated/powdered limestone (safer than lime) – available at garden centers
- ❖ Wide range of litmus paper with color matching charts
- ❖ Eyedropper

Procedure:

1. Fill the cup $\frac{1}{2}$ full of distilled water. Measure the pH by dipping a piece of litmus paper into the water. Match the color to the color chart.
2. Label this cup normal rainwater and add two drops of acid solution. Measure the pH by dipping a piece of litmus paper into the solution. Match the color to the color chart. Record the pH number in the data chart below. *Normal rain should be 5 to 5.6 on the pH scale.*
3. To this normal rainwater add 10 more drops of acid solution (3 drops at a time). Stir the solution and test it with pH paper each time you add 3 drops. This represents added acid from the burning process of fossil fuels. Match the color to the color chart. Record the pH number in the data chart below. *Acid rain has a pH below 5.0.*
4. Add a pinch of powdered limestone to the same cup and stir your solution. In a power plant, granulated limestone (similar to lime) is added to the smoke of a power plant before it leaves the smoke stack. Measure the pH of the acid rain water after you have added the lime and record the result on the data chart.

Acid Rain Neutralization Lab Data Chart

Liquid	PH Level
Distilled Water	
Normal Rainwater	
Acid Rain Water	
Acid Rain Water after adding lime	

Conclusions:

1. Did the pH of the acid rain water become more acidic (lower pH number) or more basic (higher pH number) after it was treated with lime?
2. Water for drinking should not be acidic or basic. What pH number would indicate a neutral safe pH? Hint: If you are not sure, test some distilled water with pH paper.
3. Power plants use the term “scrubbing” to describe methods of cleaning the smoke emitted by their stacks. By “scrubbing”, what are they adding to the smoke? Does this help prevent acid rain from forming?
4. What are some of the habits/routines of you and your family that add acid rain agents to the air? Remember that anytime fossil fuels (coal, oil, gasoline) are burned, acid rain causing agents escape into the air.

Extensions:

1. Catch some rainwater in a clean glass container and test it with your litmus paper.
2. List some ways you can help with the acid rain problem.

Acid Rain & Scrubbing

Part C – Acid Rain Experiment

One part of your job is conducting experiments. You want to gain a better understanding of the cleaning process power plants use during coal burning. You will complete a lab report using the scientific method as you conduct your experiment to simulate (or copy) the limestone neutralizing process. Use the form below.

<i>Acid Rain Neutralization Lab Report</i>	
Title	
Hypothesis	
Materials	
Procedure	
1	
2	
3	
Data	
Results	
Conclusion	

Acid Rain & Scrubbing

Part D – Summarize

Summarize your reaction to what you have learned about coal use, acid rain and clean coal technology. Give reasons for the way you feel using details from the text.

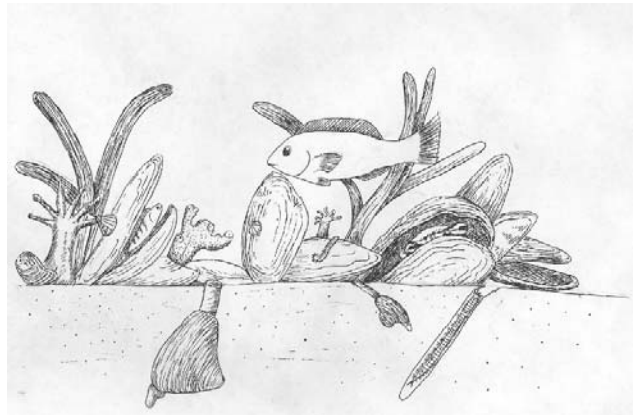
Environmental Impacts

4.3 Environmental Investigators

Read the following story to learn about how solutions to environmental problems need to be found:

“A Story from the Past: Green Oysters (1960’s)”

During the mid-1960’s, Wally Watermen dredged oysters from the Patuxent River to make a living. Early one fall morning, he noticed something odd after prying open some oysters from his catch. Most of them were green! Wally’s weathered face looked puzzled. Curious about the cause of this unusual circumstance, Wally wondered if the new power plant had anything to do with the problem. He decided to express his concerns to the Chesapeake Biological Laboratory in nearby Solomons, Maryland. They promised to look into the matter.



During the next few years, researchers worked hard to uncover the cause of the oyster greening. Oysters, which are continually filtering water through their bodies, give a good indication of current levels of pollution. The study concluded that the greening of Patuxent oysters was caused by high amount of copper in the water near the power plant. Although not all the copper in the water came from the plant, scientists recognized that the problem did, in fact, arise shortly after the power plant began operation.

Further investigation showed that the piping used in condenser tubing for their cooling system at the plant was made of copper. As a result, copper was discharged into the water due to corrosion of the tubes. Eventually, the tubes were replaced with titanium, another heavy metal that does not corrode as easily and appears to be better for the environment.

Since then, more power plants have replaced their copper tubing with titanium. Great news for the oyster!

Environmental Investigators

Present Day Concerns

You have just read a story about an environmental problem. The important part of the story is that people discovered a way to solve the problem: replacing the pipes with another metal that does not affect the environment. Listed below are a number of issues involving the production of electricity by power plants. You will be part of a research team to try to further investigate the issue and to propose possible solutions. Part of your research will be to find out if these are real problems and issues. A good scientist and a good citizen who recognizes an environmental problem also propose ways to solve the problem.

Fly Ash Piles

Enormous amounts of coal are used to produce steam to make electricity at power plants. When coal is burned, fly ash is the leftover product. What happens to the fly ash? Is it a problem for the environment?

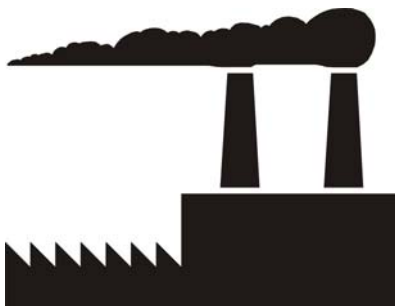
Water Cooling and the Chesapeake Bay

Water is used to cool down the operation of power plants. Canals, rivers, groundwater and cooling towers make up this cooling process. What happens to this water after it is used in the cooling process? Does this affect animal life in the water?

Transmission Lines and Rights of Way

Power lines help distribute electricity from power plants to businesses and homes. How is the land and air affected by these larger power lines?

After you have chosen a problem to investigate, you will need to research the issue. Use the graphic organizer on the next page.



Environmental Investigators Report Form

Description of Problem/Issue
<i>Evidence of Problem/Issue</i>
<i>Proposed Solution(s)</i>
<i>Other Alternative Solutions</i>